

Attribution externalities in advertising markets

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Doctoriales *i*³ May, 27th 2020

- ▶ Thesis on empirical analysis of targeted advertising in CIFRE with Ekimetrics.
- ▶ Access to a lot of advertiser's sales and advertising data.
- ▶ Implement microeconomic analysis in Ekimetric's activity

Today's research question:

- ▶ Is online advertising overpriced?
- ▶ How does offline advertising impacts online ads effectiveness?

1. Theoretical framework: advertising ecosystem

1.1 On and off the line: what's different?

1.2 Advertising: pricing and externalities

2. Misattribution problem

2.1 Ad market players behavior

2.2 Misattribution externality and implications

3. Preliminary empirical analysis

3.1 Data

3.2 Adstock computation

3.3 Exploring the offline-online relationship

4. References

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Digital now represents the majority of media ad spending.

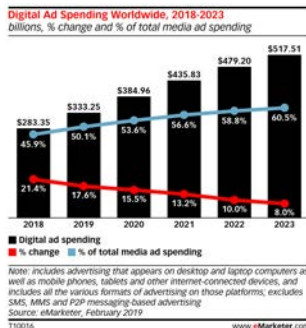


Figure: Digital ad spending 2019 (eMarketer)

What drives this trend? Tracking of ad effectiveness, low targeting cost, price discrimination (Goldfarb, 2014).

Table: Differences between online and offline ad markets

	Differences
Economic	Industrial Organization Market power Players Pricing: GRP vs ROI
Technological	Targeting capabilities Effectiveness tracking
Media	Format

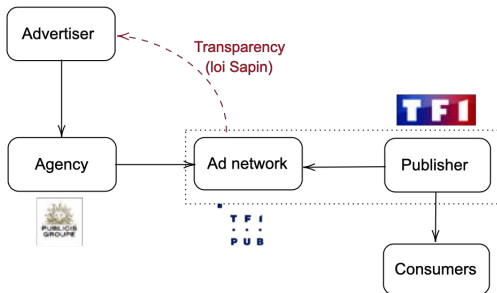


Figure: Offline advertisement (e.g. TV, radio, print, outdoor advertising) industrial organization.

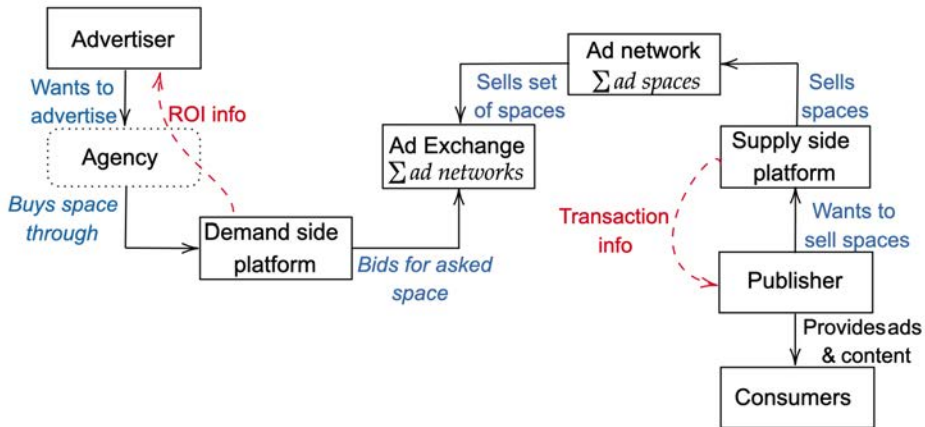


Figure: IO based on Estrada-Jiménez et al. (2019). Several platforms provide spaces, targeting, pricing or management services to both sides.

Offline ads are priced at **audience**.

- ▶ Advertisers pay for a GRP (Gross Rating Point).
- ▶ Measure guaranteed by trustworthy third-party (Médiamétrie).
- ▶ *Pricing*: rate grids established by media and negotiated with each advertiser.

Online ads prices are based on an expected **return** (clicks in CPC, acquisition in CPA)

- ▶ Those insights are calculated by ad sellers themselves.
- ▶ *Pricing*: Advertisers compete on a Vickrey auction where each bids a fee per views, click or purchase.

- ▶ **Adstock** (Broadbent, 1979) : share λ of ad expenditures I_t still efficient after the diffusion period:

$$A_t = I_t + \sum_{n=1}^{t-1} \lambda^n I_{t-n}.$$

- ▶ **Halo** effect: advertising for a good may rise consumer's utility for similar goods or brands.

Adstock & halo effects are **externalities**: neither advertisers or consumers pay for it.

The magnitude of advertising externalities depends on the **diffusion** of ad complement.

(Becker and Murphy, 1993)

Advertising is *complementary* to the advertised product. Consumer values advertising according to its preferences.

- ▶ Advertising conveys *information* (Stigler, 1961; Nelson, 1974).
- ▶ But also *narratives*: subjective content.

	Information	Narratives
Content	Objective	Subjective
Utility distribution	Uniform	Heterogeneous
Differentiation	Vertical	Horizontal
Social utility	Often none	Bandwagon effect* Addiction

Table: Economic characteristics of information and narratives.

*Bandwagon effect refers to [Leibenstein \(1950\)](#).

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ROI: indicator of online advertising efficiency.

- ▶ Click and conversions are provided by (**dominant**) ad-sellers¹.
- ▶ Cost of doing complementary analysis.
- ▶ **Credence good?** More like oligopoly market with high opportunity cost.

Attribution models determines:

- ▶ Advertiser's media futur media investment. (**Berman, 2018**).
- ▶ Consumer's welfare (**Tucker, 2013**).
- ▶ Competition, demand and price for online spaces (**Li et al., 2016**).

¹Via consumer tracking technologies

What is **Misattribution** ?

- ▶ 1. Online ROI includes offline advertising positive externalities (adstock and halo).
 - ▶ *What brings consumers to search for a product/a brand on Google or Amazon ?*
- ▶ 2. Online ROI captures competitor's notoriety investment.
 - ▶ *A firm can buy its competitors keywords or audience on Google or Facebook: Interflora vs Florajet.*
 - ▶ Absence of Google's competitors: Interflora can't compete with Florajet elsewhere.

Measurement stake: quantifying the amplitude of misattribution externality via a causal relationship:

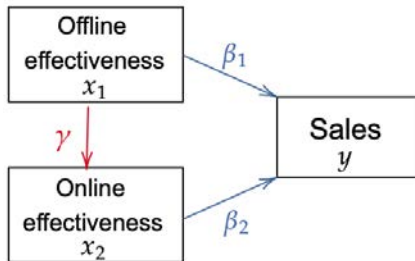


Figure: Hypothetical interaction between offline advertisement, online advertisement and sales.

Once the magnitude of misattribution externality have been quantified, correlating it to others indicators can help to understand market implications:

Table: Measuring market implication of misattribution

Implication for:	Correlating misattribution to
Consumers	Retail prices
Advertisers	Audience price
Offline media	Advertiser's offline investment
Online media	Slot prices

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	N	Mean	St. Dev.	Min	Median	Max
Sales Y_t	256	28 869	12 032	9 625	28 185.5	93 060
Price P_t	256	42	8	26	42	120
Number of stores S_t	256	53	11	54	63	73
Offline ad investment	256	71 868	114 606	0	13 042	563 746
Online ad investment	256	33 406	44 893	0	19 550.5	349 099

Table: Sales and advertising data from an **iconic** jean brand. Data available on a weekly basis from 2015 to 2019. Sales and prices are available per product (e.g. Jeans, T-shirts). Offline and online investment are also available by media (e.g. TV, Radio, Facebook, Display). However, for this preliminary analysis, we used aggregated sales, price and advertising data.

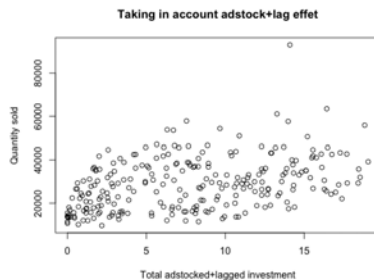


Table: Ad-sales relationship before and after taking in a account a **negative exponential lagged** adstock ($v = 0.1$ and λ depends on each media):

$$A_t^{Off} = 1 - e^{-vI_{t-2}} + \lambda A_{t-3}$$

$$A_t^{On} = 1 - e^{-vI_{t-1}} + \lambda A_{t-2}$$

Computing a simple sales-advertising regression:

$$\begin{aligned} Y_t = & \alpha + \beta_1 \log(P_t) + \beta_2 S_t \\ & + \beta_3 A_t^{Off} + \beta_4 A_t^{On} + \beta_5 (A_t^{On})^2 \\ & + \theta \mathbf{M} + \gamma \mathbf{Y} + \varepsilon_t \end{aligned}$$

- ▶ $\mathbf{M}$ and $\mathbf{Y}$ are vectors for month and year dummies.
- ▶ β_1 is price elasticity.
- ▶ β_3 and β_4 are offline and online advertising **marginal effectiveness**.
- ▶ With a quadratic term, **marginal online ad effectiveness** is measured by $\beta_4 + 2\beta_5$.

	Sales
$\log(P_t)$	-27,895.3*** (3,681.785)
S_t	797.9*** (286.426)
A_t^{off}	461.1** (209.225)
A_t^{on}	1,452.1** (582.317)
$(A_t^{on})^2$	-140.3** (56.700)
α	80,566.2*** (17,067.600)
Observations	256
Adjusted R ²	0.77

Note: *p<0.1; **p<0.05; ***p<0.01

- ▶ Positive and significant adstock coefficients.
- ▶ Diminishing marginal effect of online advertisement:
 $(A_t^{on})^2 < 0$.
- ▶ Saturation threshold reached at:

$$A_t^{on} = \left| \frac{\widehat{\beta}_4}{2\widehat{\beta}_5} \right|$$

We are interested in quantifying the effect of offline media on online advertising effectiveness.

- ▶ Proxy for effectiveness: local online advertising elasticity:

$$\eta_t = \frac{\Delta Y_t / Y_{t-1}}{\Delta A_t^{On} / A_{t-1}^{on}}.$$

- ▶ How offline adstock affects the positive part of η ?

$$\eta_t^+ = \alpha + \beta_1 A_t^{off} + \beta_2 P_t + \theta \mathbf{M} + \gamma \mathbf{Y} + \varepsilon_t.$$

	η^+
A_t^{off}	79.4* (47.1)
P_t	-91*** (25.2)
α	2836.4*** (902.2)
Observations	119
Adjusted R ²	0.12
Note: *p<0.1; **p<0.05; ***p<0.01	

- Positive relationship between offline adstock and online ad elasticity of demand!
- **However:** low R^2 and significance threshold.
- May be due to the aggregated level of the analysis.

Findings

- ▶ Adstock modeling is decisive in advertising's empirical analysis. Must be based on microeconomic assumptions.
- ▶ Adstock allows to calculate saturation effects in online advertising.
- ▶ For an iconic brand: offline adstock seems to influence online ad effectiveness.

Limitations

- ▶ Limited *causal* analysis and dataset.

To be done, next:

- ▶ Incorporating causal modeling: e.g. Path modeling, IV, Backdoor adjustment, Bayesian networks.
- ▶ Using more complete datasets to compute:
Offline adstock $\Rightarrow$ Clicks (or conversion).
- ▶ Implementing competitor's investment in modeling.
- ▶ Robustness check: ε 's heteroskedasticity and autocorrelation.

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